
Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.


# Impact of COVID-19 pandemic on alcohol-related hepatitis admissions: Analysis of nationwide data 2016-2020

Aalam Sohal MD , Hunza Chaudhry MD , Jay Patel MD , Nimrat Dhillon MBBS , Isha Kohli MBBS , Dino Dukovic BS , Marina Roytman MD,FACP , Kris V. Kowdley MD, FACP, FAASLD, FACG, AGAF

PII: S0002-9629(23)01218-1
DOI: https://doi.org/10.1016/j.amjms.2023.06.002
Reference: AMJMS 1919

To appear in: *The American Journal of the Medical Sciences*

Received date: 5 March 2023
Accepted date: 2 June 2023

Please cite this article as: Aalam Sohal MD , Hunza Chaudhry MD , Jay Patel MD , Nimrat Dhillon MBBS , Isha Kohli MBBS , Dino Dukovic BS , Marina Roytman MD,FACP , Kris V. Kowdley MD, FACP, FAASLD, FACG, AGAF , Impact of COVID-19 pandemic on alcohol-related hepatitis admissions: Analysis of nationwide data 2016-2020, *The American Journal of the Medical Sciences* (2023), doi: https://doi.org/10.1016/j.amjms.2023.06.002

# Impact of COVID-19 pandemic on alcohol-related hepatitis admissions: Analysis of nationwide data 2016-2020

**Short Title- Rise in alcohol-related hepatitis due to COVID-19**

Aalam Sohal MD [1], Hunza Chaudhry MD [2], Jay Patel MD [3], Nimrat Dhillon MBBS [4], Isha Kohli MBBS [5], Dino Dukovic BS [6], Marina Roytman MD,FACP [7], Kris V. Kowdley MD, FACP, FAASLD, FACG, AGAF [1,8]

[1] **Liver Institute Northwest,** Seattle, WA

E-mail address- asohal@liverinstitutenw.org

[2] **Department of Internal Medicine, University of California, San Francisco Fresno, San Francisco,** CA

E-mail address- hunza.chaudhry@ucsf.edu

[3] **Department of Internal Medicine, Orange Park Medical Center,** Orange Park, FL

E-mail address- jayyapatel@gmail.com

[4] **Sri Guru Ram Das Institute of Medical Sciences,** Punjab, India

E-mail address- dhillon0330@gmail.com

[5] **Graduate Program in Public Health, Icahn School of Medicine, Mount Sinai,** New York, NY

E-mail address- ishakohli689@gmail.com

[6] **Ross University School of Medicine,** Miramar, FL

Email address- dinodukovic@gmail.com

[7] **Department of Gastroenterology and Hepatology, University of California, San Francisco Fresno, San Francisco,** CA

E-mail address- marina.roytman@ucsf.edu

[8] **Elson Floyd College of Medicine, Washington State University, Spokane, WA**

E-mail address- kkowdley@liverinstitutenw.org

**Corresponding Author:**
Kris V Kowdley, MD, FACG, FAASLD
Liver Institute Northwest
3216 NE 45th Pl Suite 212
Seattle, WA
98105
kkowdley@liverinstiutenw.org

**Abstract**

**Background**

The coronavirus disease 2019 (COVID-19) pandemic was a public health crisis affecting medical, social, and psychological wellness. In a previous study, we reported a rise in alcohol-related hepatitis (ARH) cases between 2019 and 2020 in the central valley of California. Our goal in the current study was to assess the impact of COVID-19 on ARH at a national level.

**Methods**

We used data from the 2016-2020 National Inpatient Sample. All adult patients diagnosed with ARH (ICD10 K70.1 and K70.4) were included. Information was collected regarding patient demographics, hospital characteristics, and severity of hospitalization. We analyzed the annual percentage changes (PC) between 2016-2019 and 2019-2020 to assess the impact of COVID-19 on hospitalizations. Multivariate logistic regression analysis was performed to identify factors associated with increased ARH admissions between 2016-2020.

**Results**

A total of 823,145 patients were admitted with ARH. The total number of cases increased from 146,370 in 2016 to 168,970 in 2019 (annual percentage change (PC) 5.1%), while the cases increased to 190,770 in 2020 (PC 12.4%). The PC in women was 6.6% between 2016-

2019, which increased to 14.2% between 2019-2020. In men, PC increased by 4.4% between 2016-2019 to 12.2% between 2019-2020. On multivariate analysis, after adjusting for patient demographics and hospital characteristics, there was 46% increased odds of admission with ARH in 2020, compared to 2016. The total number of deaths increased from 8,725 in 2016 to 9,190 in 2019 (PC 1.7%), while the total number of deaths increased to 11,455 in 2020 (PC 24.6%).

**Conclusions**

A sharp rise in the cases of ARH between 2019-2020 was noted, which aligned with the COVID-19 pandemic. Not only did total hospitalization increase, but an increase in mortality was also noted, reflecting higher severity in the patients admitted during the COVID-19 pandemic.

**Keywords:** Pandemic, COVID-19, Alcohol-related hepatitis, National Inpatient Sample.

**Introduction**

The COVID-19 pandemic was unprecedented in scale and affected millions worldwide.[1] The physical and mental well-being of individuals was adversely affected by stay-at-home orders implemented during COVID-19.[2,3] The societal disruptions that ensued were associated with increased alcohol use and the risk of developing alcohol use disorder.[4] During the early days of the COVID-19 pandemic (March-April 2020), alcohol sales were noted to increase substantially.[5] Online liquor sales also increased by 262% during the same time period.[6] A study by Morton et al. also reported a rise in alcohol sales in 2020 compared to 2015-2019.[7] Their study reported that monthly percentage increases in alcohol sales ranged from 14 to 44% during the pandemic. Another study performed on a nationally representative sample by Pollard et al., which included over 1500 patients, found increased alcohol consumption of

14% overall from 2019 to 2020.[8] Increase in the rates of alcohol consumption during the COVID-19 epidemic has been previously documented.[9,10]

Alcohol-related hepatitis (ARH) may present with severe liver disease and is associated with bleeding from varices, hepatic encephalopathy, and acute renal failure.[11] In-hospital mortality rates are high in patients with ARH, especially those with complications such as coagulopathy, hepatic encephalopathy, and acute renal failure.[12]

We previously described the rise in cases and severity of ARH during the COVID-19 pandemic in the three-hospital system in Fresno, California.[13] Gonzalez et al. reported a similar rise in ARH cases in Detroit, Michigan, during COVID-19.[14] However, there are no reports from nationwide data on temporal trends in hospitalizations due to ARH during the COVID-19 era. Our study examined ARH hospitalizations before and during the COVID-19 pandemic using data from National Inpatient Sample (NIS).

**Methods**

**Data Source**

The National Inpatient Sample (NIS), managed by the Agency for Healthcare Research and Quality, is a national database of hospitalizations in the United States.[15] It contains information on hospitalizations from 37 states and has been used to estimate disease burden and outcomes. Detailed information about the database has been described previously.[16-18]

**Study Population**

We used ICD-10 (International Classification of Diseases, Clinical Modification-10th Revision) codes (K70.1 and K70.4) to identify patients with a diagnosis of alcohol-related hepatitis. The patients were divided into primary hospitalizations for ARH and secondary hospitalizations for ARH. Hospitalization was considered primary if the diagnosis code for ARH was listed in the first position. The remaining admissions were considered secondary. The current study did not require Institutional Review Board (IRB) approval, given the data are anonymized and de-identified. This study is in compliance with the Helsinki Declaration.

**Study Variables**

The following patient-focused data were collected: age, gender, race, insurance status, income quartile, intensive care unit (ICU) admission rates, shock, and mortality. The following hospital-focused data were collected: geographic region, hospital size, location (rural versus urban), and academic affiliation (teaching versus non-teaching). The following severity-focused data were collected: in-hospital mortality, ICU admission, and shock.

**Statistical Analysis**

All statistical analyses were performed using the NIS's sample weights and stratified sample design to obtain nationally representative estimates. We used Chi-square and independent sample t-tests to compare variables as appropriate. Percentage changes in hospitalization demographics, characteristics, and surrogate markers of severity were compared between 2016-2019 and 2019-2020 (Early COVID-19 pandemic) to assess if COVID-19 affected hospitalizations for ARH. The percentage change was calculated by dividing the difference in the number of cases between the years by the cases noted during the index year and the

time period (in years). To identify predictors of ARH hospitalization, multivariate logistic regression was developed. The variables included a year of admission, patient demographics and hospital characteristics.

## Results

### National estimates of ARH-related hospitalization rates in the US from 2016-2020

A total of 823,145 patients were admitted with a diagnosis of ARH between 2016-2020. The total cases of ARH hospitalizations increased from 146,370 in 2016 to 168,970 in 2019 (PC = 5.1%). Cases increased from 168,970 in 2019 to 190,770 in 2020 (PC = 12.9%). Out of the 190,770 patients admitted in 2020, 3,675 (1.93%) of the patients had concomitant COVID-19. The significant increase in the total admission rates was attributable to the rise in admissions for secondary diagnosis of ARH. These results are presented in Figure 1. Among patients with ARH as a secondary diagnosis, the most common primary diagnoses were alcohol withdrawal, alcoholic cirrhosis of the liver with ascites, sepsis, and alcohol-induced pancreatitis. The total number of cases with each primary diagnosis is provided in Supplementary Table 1.

### Demographics of ARH patients

#### *Age*

Although there was a rise in the cases of ARH across most age groups, the rate of increase was noted to be drastically higher in younger patients. In patients aged 18-44 years, the number of cases increased from 48,660 in 2016 to 88,115 in 2019 (2016-2019 PC = 9.2%), and to 96,525 in 2020 (2019-2020 PC = 19.8%). The rise in the cases was also noted in patients aged 45-64 and > 65 years old, however, the rise in these two groups was lower

than in the younger group (2019-2020 PC = 9% and 5%, respectively). The average PC between 2016-2019 and 2019-2020 is presented in Supplementary Table 1. This is presented in Figure 2.

***Gender***

The rise in cases was noted in both genders. In men, the cases increased from 99,170 in 2016 to 112,445 in 2019 (2016-2019 PC = 4.4%), to 126,185 in 2020 (2019-2020 PC = 12%). A similar increase was also noted in women, from 47,140 in 2016 to 56,515 in 2019 (2016-2019 PC = 6.6%) to 64,580 in 2020 (2019-2020 PC = 14.2%). This is presented in Figure 3.

***Race***

Most of the study population was white, although the increase was observed in all racial groups. The increase in the cases during the COVID-pandemic was noted to be highest among Native American (25%), followed by African American (17%) and Hispanic patients (13%). A complete list of patient demographics, stratified by year, is presented in Table 1.

***Income Quartile and Insurance Status***

There was an increase in the cases in all income quartiles. Between 2016-2019, the PC was higher in the top two income quartiles (7.43% and 5.42%), while during the COVID-19 pandemic, the highest increase in cases was noted in the lower two income quartiles (13.65% and 19.73%).

Prior to the COVID-19 pandemic (2016-2019), an increase in cases was noted in all insurance groups. The increase was higher among those with public insurance (Medicaid) and those

without health insurance. During the COVID-19 pandemic, there was a decrease in the cases among patients with Medicare insurance, while a substantial increase was noted in patients with private insurance and Medicaid insurance (17.05% and 17.42%, respectively). The results are depicted in Figure 4.

**Hospital Characteristics of ARH Admissions**

The majority of the admissions were noted in urban and teaching hospitals. Most patients admitted with ARH were in the South of the US. The highest increase in cases during the COVID-19 pandemic was noted in the West (15%), followed by the South (13.7%) and Midwest (11%). This is presented in Figure 5. Information regarding hospital characteristics, stratified by year, is presented in Table 2.

**Predictors of ARH hospitalizations**

On multivariate analysis, we note that there was a statistically significant difference in the rates of ARH based on the year of admission. There were 18.7% higher odds of having an admission with ARH in 2019, compared to 2016 after adjusting for patient demographics and hospital characteristics. The highest odds of admission were noted in 2020. There were 46% higher odds of having an ARH admission in 2020, compared to 2016. Patient-related factors that were associated with increased odds of ARH admission were being middle aged (45-64 years old), males, Native American race, Medicaid and Uninsured status. The results are presented in Table 3.

**Outcomes**

***In-hospital mortality***

The mortality in patients with ARH increased from 8,725 in 2016 to 9,190 in 2019 (2016-2019 PC =1.7%). A sharp rise was noted in in-hospital mortality in 2020, with 11,455 patients suffering in-hospital mortality (2019-2020 PC = 24.6%). The information regarding severity, stratified by year, is presented in Figure 6. On further stratification of patients who suffered in-hospital mortality in 2019 and 2020, we noted that the highest increase in mortality was noted in younger patients aged 18-44 in 2020, compared to 45-64 years and greater than 65 years (39.7% vs. 20.7% and 16.9%) respectively. The mortality among females increased by 28.9% compared to 22.1% in males. Further information is provided in Supplementary Table 2.

***ICU admissions***

There has been an increase in ICU admissions from 13,195 in 2016 to 15,425 in 2019 (2016-2019 PC = 5.6%). The cases increased further to 18,165 in 2020 (2019-2020 PC = 17.7%). Between 2019 and 2020, we noted an higher increase in the ICU admissions among younger patients aged 18-44 years (27.6% increase), females (23.1% increase), Asian pacific islanders (100% increase) and African Americans (37.1% increase). The results are provided in the Supplementary Table 3.

***Shock***

There has been an increase in admissions with shock from 10,070 in 2016 to 13,275 in 2019 (2016-2019 PC = 10.6%). The cases increased further to 16,585 in 2020 (2019-2020 PC = 24.9%)

***Liver Transplantation***

The number of liver transplants for patients with alcohol-related hepatitis increased from 555 in 2016 to 660 in 2018 and 1,055 in 2019 (2016-2019 PC=30.3%), while the number of liver transplants in 2020 was noted to be 1,300 (2019-2020 PC=23.2%)

**Discussion**

While there have been studies highlighting the increase in alcohol use during the COVID-19 pandemic, there is limited research on the national impact of the increase in alcohol consumption during the pandemic on alcohol-related liver disease in general and on the burden of ARH specifically. In our study of the large, nationwide patient sample, hospitalizations for ARH increased by 12.9% from 2019 to 2020. This increase is higher than the previous rate of 5.1% between 2016 to 2019, emphasizing the significant impact of the COVID-19 pandemic on the previous trend of rising cases of ARH in the pre-pandemic era.

Patients in the youngest age group (18-44) had a more significant rise in cases of ARH during the COVID-19 pandemic (2019 to 2020 PC = 19.8%) compared to the older patients and a much more significant increase compared to the pre-pandemic era (2016-2019 PC = 9.2%). These findings are consistent with our previous regional study, which highlighted drastic increases in ARH among younger patients during the COVID-19 pandemic. We had previously hypothesized that multiple factors could contribute to the rise of AHR in younger patients, including disruptions in college life, transition to virtual learning, financial stressors due to lack of job opportunities, and isolation from friends and family.[13] Furthermore, the loss of support systems in those with substance abuse orders might have also contributed to

the increase in ARH admissions among the younger population. This significant increase is of great concern as patients with ARH are at risk of progression to end-stage liver disease in addition to the severe consequences of acute ARH itself. Julien et al. estimated, using microsimulation models, that a short-term increase in alcohol consumption during the pandemic resulted in an increase in mortality (8,000 cases) and liver failure (18,700 cases), resulting in a loss of 8.9 million disability-adjusted life years between 2020-2040. The study noted that any persistent increase would result in increased mortality, particularly amongst younger cohorts born after 1960, further highlighting that this short-term increase in alcohol consumption can have long-lasting consequences.[19]

A rise in cases of ARH was noted in both genders, although a higher annual increase was noted among women. In our previous study of a single hospital system in California, we noted an increase in the cases of ARH among women; however, the difference did not reach statistical significance.[13] A study by Pollard et al. reported a 17% increase in weekly drinking and a 41% increase in heavy drinking among women in 2020 compared to 2019.[8] Previous studies have documented gender-based differences in response to life stressors, with the study by Barbosa et al. indicating that women have experienced more psychological stressors due to the pandemic disruptions and were more likely to exceed recommended drinking limits as a coping mechanism compared to men.[20] Another study by Hahm et al. reported that COVID-19-related grief was associated with heavy drinking behavior in women.[21] These findings are of great concern as women are at increased risk for developing alcohol-related liver disease due to differences in alcohol dehydrogenase activity, sex hormones, body fat distribution, and liver volume between the two genders.[22-24]

With regard to race, the increases in cases were noted among all races; the highest increases were noted among Native American, followed by African American and Hispanic patients. This is similar to another study by Damjanovska et al. of a cohort of over 8 million patients in which African American patients were more likely to not only be diagnosed with and managed for alcoholic hepatitis (OR = 2.63) but also with alcohol-related pancreatitis (OR = 2.17) and alcohol-related gastritis (OR= 3.09).[25] This racial disparity potentially underscores the more notable difficulties experienced by minority populations during the pandemic. Almost a quarter of African American or Hispanic patients in 2020 were employed in service industry jobs, an industry particularly impacted by restrictions and layoffs during the pandemic.[26] In April 2020, a study surveying various groups found that 61% of Hispanic and 44% of African American patients stated they or someone in their home had experienced wage or job loss due to the pandemic, compared to 38% of Whites.[27]

A concerning finding is the increasing severity of ARH hospital admissions. Between 2019 and 2020, there was a 17.7% increase in ICU admissions, and 24.9% increase in rates of shock, and a 24.6% increase in in-hospital mortality, as compared to 5.6%,10.7,%, and 1.7% increase, respectively between 2016-2019. The mortality findings prior to the pandemic are similar to the study by White et al., which reported a 2.2% mean annual change from 1999 to 2017.[28] Our study also noted an increase in liver transplantation rates during 2019 and 2020, corresponding to an increase in the cases of ARH. The substantial increases in morbidity and mortality of ARH, especially in younger patients, carry massive societal implications from the standpoint of years of life lost as well as significant increases in healthcare spending to care for these critically ill patients. They also reported an increase in the cases.

Another study by Sedarous et al. noted an increase in hospitalizations for alcohol-related liver disease (ALD) compared to pre-pandemic years, with an increase in mortality among patients with ALD[29]. Their study noted an increase in hospitalizations for ARH from 19,240 in 2019 to 22,185 in 2020. Although their study used the same database, it is unclear why the total number of ARH cases in their analysis is lower than our analysis. The methodology described by the authors does not explain what ICD-10 codes for ARH were used in the analysis. We believe that the difference in the numbers is likely due to the use of different ICD-10 codes. Recently another study by Kulkarni et al. reported a 23% increase in the mortality in 2020, compared to 2019 using data from 2019-2020 center of disease control and prevention (CDC) WONDER multiple causes of death database.[30] Their study reported marked increase in deaths among American Indian/Alaska Native patients, which aligns with our study findings.

Given the features of the NIS dataset, we could not calculate illness scores such as MELD-Na or Child-Pugh. Secondly, NIS does not provide patient identifiers, and therefore, hospital re-admissions cannot be tracked. ICD-10 diagnosis codes are used to identify patients, and the possibility of coding errors and erroneous diagnosis coding is always a limitation of such studies. Nevertheless, we believe the large population size and the nationwide sample size are important strengths of our study and outweigh these limitations. We believe that further study of additional population-based databases and examination of the socioeconomic and health outcomes related to ARH in the COVID-19 era is indicated.

**Conclusions**

Our study found significant increases in the case numbers and severity of ARH during the COVID-19 pandemic across the United States. Models have predicted that even short-term increases in alcohol use can have drastic short and long-term consequences on the population basis. Our findings highlight the urgent need for concerted efforts on the part of health care providers and policy makers for early identification, treatment and primary prevention of alcohol use disorder to prevent the tsunami of alcohol-related liver disease in the coming years.

**Conflict of Interest**

All authors report no conflict of interest.

**Source of Funding**

None.

**Author Contributions**

Aalam Sohal, Hunza Chaudhry, Jay Patel, Nimrat Dhillon, Isha Kohli, and Dino Dukovic planned the study, reviewed the literature, drafted the manuscript, revised it for important intellectual content, and were involved in the final approval of the version to be published. Aalam Sohal, Hunza Chaudhry, Marina Roytman and Kris Kowdley revised the article for important intellectual content and were involved in the final approval of the version to be published.

**References**


1. **Edouard Mathieu, Hannah Ritchie, Lucas Rodés-Guirao et al.** "Coronavirus Pandemic (COVID-19)". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/coronavirus' Accessed 5th March 2023
2. **Tull MT, Edmonds KA, Scamaldo KM, et al.** Psychological outcomes associated with stay-at-home orders and the perceived impact of COVID-19 on daily life. Psychiatry Res. 2020;289:113098.
3. **Dai J, Sang X, Menhas R, et al.** The Influence of COVID-19 Pandemic on Physical Health-Psychological Health, Physical Activity, and Overall Well-Being: The Mediating Role of Emotional Regulation. Front Psychol. 2021;12:667461. Published 2021 Aug 16. doi:10.3389/fpsyg.2021.667461
4. **Barbosa C, Dowd WN, Neuwahl SJ et al.** Modeling the impact of COVID-19 pandemic-driven increases in alcohol consumption on health outcomes and hospitalization costs in the United States. *Addiction*. 2023;118(1):48-60. doi:10.1111/add.16018
5. The Nielsen Company Rebalancing the 'COVID-19 Effect' on Alcohol Sales. [(accessed on 21 October 2020)];2020 May 7; Available online: https://www.nielsen.com/us/en/insights/article/2020/rebalancing-the-covid-19-effect-on-alcohol-sales/
6. Davis E. States Boost Hospitality Industry with Booze Delivery and Takeout Sales. [(accessed on 15 December 2022)];US News & World Report. Available online: https://www.usnews.com/news/best-states/articles/2020-03-19/more-states-offer-alcohol-delivery-and-takeout-amid-coronavirus

7. Morton CM. Alcohol sales during COVID-19 social restrictions: Initial evidence from Alcoholic Beverage Control states. *Subst Abus*. 2021;42(2):158-160. doi:10.1080/08897077.2020.1856293
8. Pollard M.S., Tucker J.S., Green H.D. Changes in adult alcohol use and consequences during the COVID-19 Pandemic in the US. JAMA Netw. Open. 2020:3.
9. **Capasso A., Jones A.M., Ali S.H. et al.** Increased alcohol use during the COVID-19 pandemic: The effect of mental health and age in a cross-sectional sample of social media users in the US. Prev. Med. 2021:145.
10. **Graupensperger S., Fleming C.B., Jaffe A.E. et al.** Changes in young adults' alcohol and marijuana use, norms, and motives from before to during the COVID-19 pandemic. J. Adolesc. Health. 2021;68:658–665.
11. **Basra G, Basra S, Parupudi S.** Symptoms and signs of acute alcoholic hepatitis. *World J Hepatol*. 2011;3(5):118-120. doi:10.4254/wjh.v3.i5.118
12. **Ali H, Pamarthy R, Bolick NL, et al.** Ten-year trends and prediction model of 30-day inpatient mortality for alcoholic hepatitis in the United States. Ann Gastroenterol. 2022;35(4):427-433. doi:10.20524/aog.2022.0718
13. **Sohal A, Khalid S, Green V et al.** The Pandemic Within the Pandemic: Unprecedented Rise in Alcohol-related Hepatitis During the COVID-19 Pandemic. *J Clin Gastroenterol*.2022;56(3):e171-e175. doi:10.1097/MCG.0000000000001627
14. **Gonzalez HC, Zhou Y, Nimri FM et al.** Alcohol-related hepatitis admissions increased 50% in the first months of the COVID-19 pandemic in the USA. *Liver Int*. 2022;42(4):762-764. doi:10.1111/liv.15172

15. Healthcare Cost and Utilization Project (HCUP) Content last reviewed October 2022 Agency for Healthcare Research and Quality, Rockville, MD. [[Accessed 14 November 2022]]. Available from: https://www.ahrq.gov/data/hcup/index.html.

16. **Sohal A, Chaudhry H, Dhaliwal A, et al.** Gender differences in esophageal variceal bleeding in the United States. *Ann Med*. 2022;54(1):2115-2122. doi:10.1080/07853890.2022.2104920

17. **Sohal A, Chaudhry H, Singla P, et al.** The burden of Clostridioides difficile on COVID-19 hospitalizations in the USA [published online ahead of print, 2023 Jan 20]. *J Gastroenterol Hepatol*. 2023;10.1111/jgh.16128. doi:10.1111/jgh.16128

18. **Sohal A, Chaudhry H, Kohli I, et al.** Hospital frailty risk score predicts worse outcomes in patients with chronic pancreatitis. *Ann Gastroenterol*. 2023;36(1):73-80. doi:10.20524/aog.2022.0765

19. **Julien J, Ayer T, Tapper EB, et al.** Effect of increased alcohol consumption during COVID-19 pandemic on alcohol-associated liver disease: A modeling study. *Hepatology*. 2022;75(6):1480-1490. doi:10.1002/hep.32272

20. **Barbosa C, Cowell AJ, Dowd WN.** Alcohol Consumption in Response to the COVID-19 Pandemic in the United States. J Addict Med. 2021 Jul-Aug 01;15(4):341-344. doi: 10.1097/ADM.0000000000000767. PMID: 33105169; PMCID: PMC8327759

21. **Hahm HC, Hsu KC, Hyun S, et al.** Psychological Distress and Heavy Alcohol Consumption Among U.S. Young Women During the COVID-19 Pandemic. *Womens Health Issues*. 2023;33(1):17-24. doi:10.1016/j.whi.2022.09.002

22. **Mezey E, Kolman CJ, Diehl AM, et al.** Alcohol and dietary intake in the development of chronic pancreatitis and liver disease in alcoholism. Am J Clin Nutr. 1988; 48(1): 148-51 [PMID: 3389321 DOI: 10.1093/ajcn/48.1.148]

23. **Bellentani S, Saccoccio G, Costa G, et al.** Drinking habits as cofactors of risk for alcohol induced liver damage. Gut. 1997; 41(6): 845-50 [PMID: 9462221 PMCID: PMC1891602 DOI: 10.1136/gut.41.6.845]

24. **Lu XL, Luo JY, Tao M, et al.** Risk factors for alcoholic liver disease in China. World J Gastroenterol. 2004; 10(16): 2423-6 [PMID: 15285035 PMCID: PMC4576304 DOI: 10.3748/wjg.v10.i16.2423]

25. **Damjanovska S, Karb DB, Cohen SM.** Increasing Prevalence and Racial Disparity of Alcohol-Related Gastrointestinal and Liver Disease During the COVID-19 Pandemic: A Population-Based National Study [published online ahead of print, 2022 Jan 10]. *J Clin Gastroenterol*.

26. "Financial and health impacts of COVID-19 vary widely by race and ethnicity " Pew Research Center, Washington, D.C. (May 5,2020) https://www.pewresearch.org/fact-tank/2020/05/05/financial-and-health-impacts-of-covid-19-vary-widely-by-race-and-ethnicity/ .

27. **Edwards K, Lopez MH.** Black Americans say coronavirus has hit hard financially, but impact varies by education level, age. Pew Research Center. https://www.pewresearch.org/fact-tank/2021/05/12/black-americans-say-coronavirus-has-hit-hard-financially-but-impact-varies-by-education-level-age/. Published June 17, 2021.

28. **White AM, Castle IP, Hingson RW, et al.** Using death certificates to explore changes in alcohol-related mortality in the United States, 1999 to 2017. *Alcohol Clin Exp Res*. 2020;44(1):178-187. doi:10.1111/acer.14239

29. **Sedarous M, Youssef M, Adekunle AD**, et al. A nationwide study of liver disease hospitalizations during the coronavirus pandemic in the United States. J Gastroenterol Hepatol. 2023 Mar 7. doi: 10.1111/jgh.16170. Epub ahead of print. PMID: 36882309.

30. **Kulkarni, N. S., Wadhwa, D. K., Kanwal, F et al.** Alcohol-Associated Liver Disease Mortality Rates by Race Before and During the COVID-19 Pandemic in the US. *JAMA health forum*, *4*(4), e230527. https://doi.org/10.1001/jamahealthforum.2023.0527

**Figure Legends**

**Figure 1:** Number of alcohol-related hepatitis (ARH) hospitalizations from 2016 to 2020.


**Figure 2:** Number of alcohol-related hepatitis (ARH) hospitalizations, stratified by age group, from 2016 to 2020.

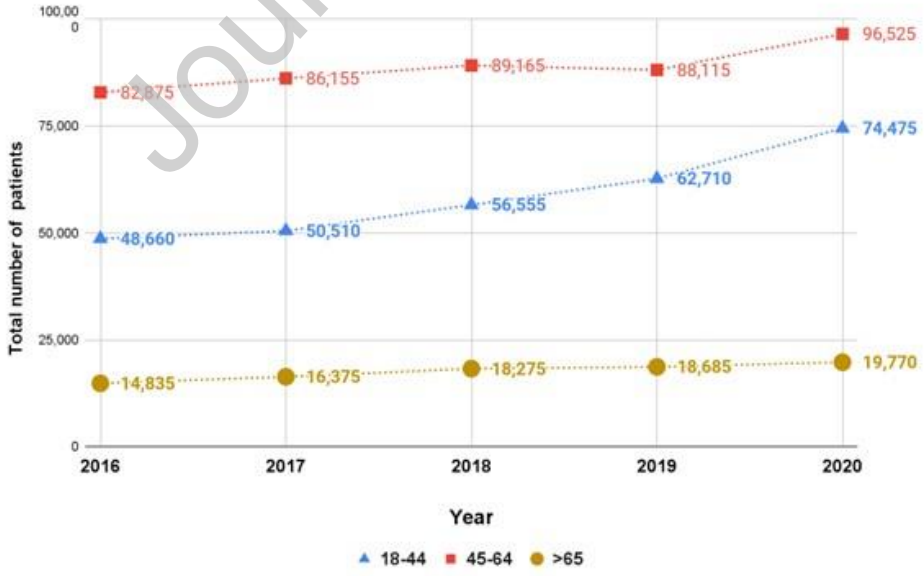

**Figure 3:** Number of alcohol-related hepatitis (ARH) hospitalizations, stratified by gender, from 2016 to 2020.


**Figure 4:** Number of alcohol-related hepatitis (ARH) hospitalizations, stratified by insurance status, from 2016 to 2020.

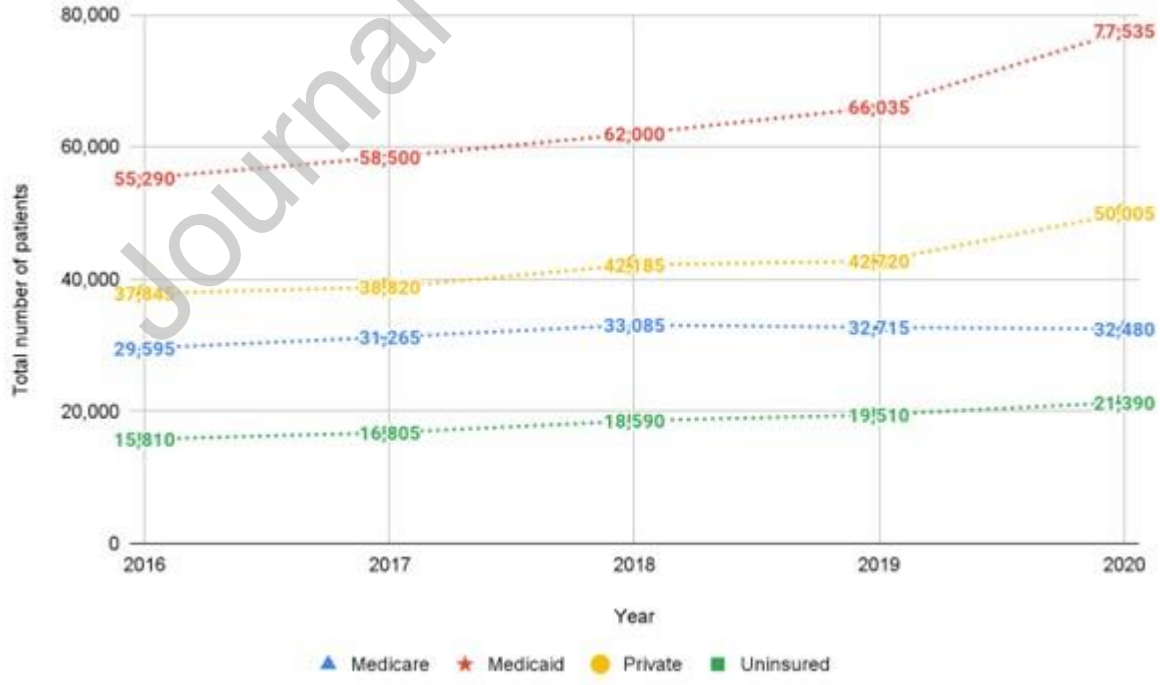

**Figure 5:** Number of alcohol-related hepatitis (ARH) hospitalizations, stratified by hospital location, from 2016 to 2020.

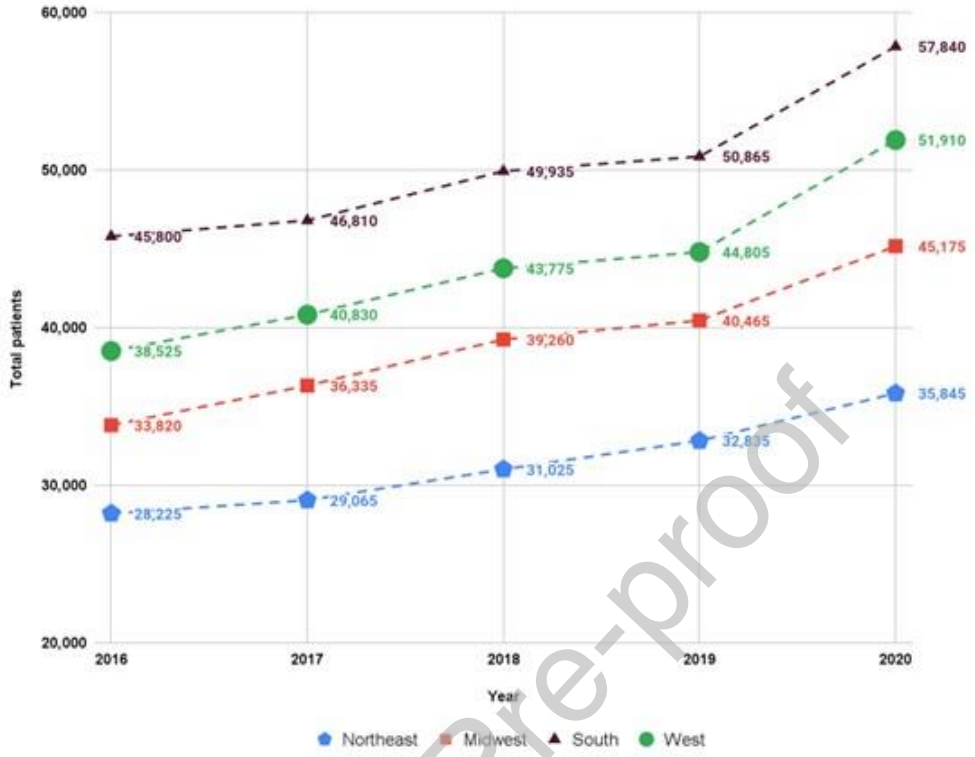


**Figure 6:** Outcomes stratified by year, from 2016 to 2020.

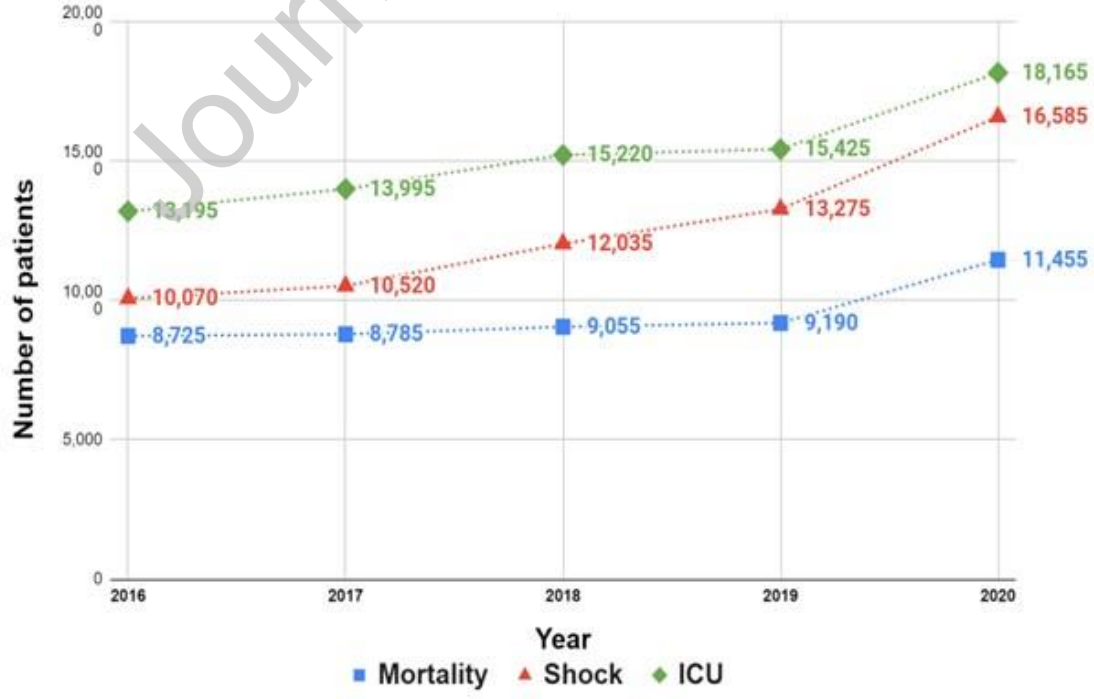

Table 1- Patient Demographics, stratified by Year

| Demographics | 2016 | 2017 | 2018 | 2019 | 2020 | p-value | APC between 2016-2019 (%age) | APC between 2019-2020 (%age) |
|---|---|---|---|---|---|---|---|---|
| **Age Category** | | | | | | **<0.001** | | |
| 18-44 | 48,660 (33.24) | 50,510 (33) | 56,555 (34.49) | 62,710 (36.79) | 74,475(39.04) | | 9.62 | 18.76 |
| 45-64 | 82,875 (56.62) | 86,155 (56.3) | 89,165 (54.37) | 88,115 (52.15) | 96,525 (50.6) | | 2.11 | 9.54 |
| >65 | 14,835 (10.14) | 16,375 (1.07) | 18,275 (11.14) | 18,685 (11.06) | 19,770 (10.36) | | 8.65 | 5.81 |
| **Sex** | | | | | | **<0.001** | | |
| Males | 99,170 (67.75) | 103,435 (67.59) | 109,705 (66.9) | 112,455 (66.55) | 126,185 (66.15) | | 4.47 | 12.21 |
| Females | 47,140 (32.21) | 49,600 (32.41) | 54,285 (33.1) | 56,515 (33.45) | 64,580 (33.85) | | 6.63 | 14.27 |
| **Race** | | | | | | **<0.001** | | |
| White | 98,660 (67.4) | 103,140 (67.39) | 111,140 (67.77) | 115,370 (68.28) | 127,720 (66.95) | | 6.65 | 10.7 |
| Black | 13,940 (9.52) | 15,150 (9.9) | 15,875 (9.68) | 16,060 (9.51) | 18,795 (9.85) | | 5.07 | 17.03 |
| Hispanic | 17,625 (12.04) | 19,325 (12.63) | 21,670 (13.21) | 22,310 (13.2) | 25,250 (13.24) | | 8.86 | 13.18 |
| Asian/Pacific Islander | 1,590 (1.09) | 1,695 (1.11) | 1,885 (1.15) | 2,095 (1.24) | 2,480 (1.3) | | 10.59 | 18.38 |
| Native American | 3,430 (2.34) | 3,680 (2.41) | 4,195 (2.56) | 4,340 (2.57) | 5,445 (2.85) | | 8.84 | 25.46 |
| **Primary expected** | | | | | | **<0.001** | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **payer** | | | | | | | | |
| Medicare | 29,595 (20.22) | 31,265 (20.43) | 33,085 (20.17) | 32,715 (19.36) | 32,480 (17.03) | | 3.51 | -0.72 |
| Medicaid | 55,290 (37.77) | 58,500 (38.23) | 62,000 (37.81) | 66,035 (39.08) | 77,535 (40.64) | | 6.48 | 17.42 |
| Private | 37,845 (25.86) | 38,820 (25.37) | 42,185 (25.72) | 42,720 (25.28) | 50,005 (26.21) | | 4.29 | 17.05 |
| Uninsured | 15,810 (10.8) | 16,805 (10.98) | 18,590 (11.34) | 19,510 (11.55) | 21,390 (11.21) | | 7.8 | 9.64 |
| **Median Household Income** | | | | | | 0.113 | | |
| Lowest quartile | 41,855 (28.6) | 42,980 (28.08) | 42,620 (25.99) | 44,975 (26.62) | 51,115 (26.79) | | 3.51 | -0.72 |
| Second quartile | 36,010 (24.6) | 38,675 (25.27) | 42,255 (25.77) | 41,755 (24.71) | 49,995 (26.21) | | 6.48 | 17.42 |
| Third quartile | 35,325 (24.13) | 37,000 (24.18) | 41,015 (25.01) | 43,200 (25.57) | 46,005 (24.12) | | 4.29 | 17.05 |
| Highest quartile | 28,935 (19.77) | 29,910 (19.54) | 33,315 (20.31) | 33,640 (19.91) | 37,565 (19.69) | | 7.8 | 9.64 |

Table 2- Hospital Characteristics, stratified by Year

| | **2016 n (%)** | **2017 n (%)** | **2018 n (%)** | **2019 n (%)** | **2020 n (%)** | **p-value** | **APC between 2016-2019 (%age)** | **APC between 2019-2020 (%age)** |
|---|---|---|---|---|---|---|---|---|
| **Hospital Region** | | | | | | 1 | | |
| Northeast | 28,225 (19.28) | 29,065 (18.99) | 31,025 (18.92) | 32,835 (19.43) | 35,845 (18.79) | | 5.44 | 9.17 |
| Midwest | 33,820 (23.11) | 36,335 (23.74) | 39,260 (23.94) | 40,465 (23.95) | 45,175 (23.68) | | 6.55 | 11.64 |
| South | 45,800 (31.29) | 46,810 (30.59) | 49,935 (30.45) | 50,865 (30.1) | 57,840 (30.32) | | 3.69 | 13.71 |
| West | 38,525 (26.32) | 40,830 (26.68) | 43,775 (26.69) | 44,805 (26.52) | 51,910 (27.21) | | 5.43 | 15.86 |
| **Hospital location** | | | | | | 0.23 | | |
| Rural | 11,080 (7.57) | 11,760 (7.68) | 11,835 (7.22) | 11,010 (6.52) | 12,675 (6.64) | | -0.21 | 11.1 |
| Urban | 132,590 (92.43) | 141,280 (92.32) | 152,160 (92.78) | 157,960 (93.48) | 178,095 (93.36) | | 6.38 | 13.52 |
| **Teaching versus non-teaching hospitals** | | | | | | **<0.001** | | |
| Non-Teaching hospitals | 50,865 (34.75) | 47,880 (31.29) | 46,550 (28.39) | 43,060 (25.48) | 47,840 (25.08) | | -5.11 | 15.12 |
| Teaching hospitals | 95,505 (65.25) | 105,160 (68.71) | 117,445 (71.61) | 125,910 (74.52) | 142,930 (74.92) | | 10.61 | 12.75 |

Table 3-Results of multivariate logistic regression model assessing the impact of year, patient demographics, and hospital characteristics on admissions for ARH

| | Adjusted odds ratio | p-value | 95% CI |
|---|---|---|---|
| **Year** | | | |
| 2017 | 1.05 | 0.01 | 1.02-1.09 |
| 2018 | 1.14 | <0.001 | 1.10-1.19 |
| 2019 | 1.19 | <0.001 | 1.14-1.23 |
| 2020 | 1.46 | <0.001 | 1.41-1.51 |
| **Age Category** | | | |
| 18-44 | Ref | | |
| 45-64 | 2.32 | <0.001 | 2.28-2.36 |
| >65 | 0.40 | <0.001 | 0.38-0.41 |
| **Sex** | | | |
| Males | Ref | | |
| Females | 0.43 | <0.001 | 0.42-0.44 |
| **Race** | | | |
| White | Ref | | |
| Black | 0.48 | <0.001 | 0.47-0.49 |
| Hispanic | 0.68 | <0.001 | 0.67-0.70 |
| Asian/Pacific Islander | 0.31 | <0.001 | 0.29-0.32 |
| Native American | 2.51 | <0.001 | 2.36-2.67 |
| **Primary expected payer** | | | |
| Medicare | Ref | | |
| Medicaid | 2.20 | <0.001 | 2.15-2.24 |
| Private | 0.94 | <0.001 | 0.92-0.96 |
| Uninsured | 3.27 | <0.001 | 3.19-3.36 |
| **Median Household Income** | | | |
| Lowest quartile | Ref | | |
| Second quartile | 1.09 | <0.001 | 1.07-1.11 |
| Third quartile | 1.22 | <0.001 | 1.19-1.24 |
| Highest quartile | 1.31 | <0.001 | 1.28-1.34 |
| Urban hospitals | 1.29 | <0.001 | 1.24-1.34 |
| Teaching hospitals | 0.92 | <0.001 | 0.90-0.95 |
| **Hospital Region** | | | |
| Northeast | Ref | | |
| Midwest | 1.01 | 0.60 | 0.97-1.05 |

| | | | |
|---|---|---|---|
| South | 0.71 | <0.001 | 0.69-0.75 |
| West | 1.17 | <0.001 | 1.13-1.21 |